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ABSTRACT

The course outline will serve as a guide to the high school student who wishes to pursue the highly exacting field of checking, gauging, and measuring parts to insure quality and reliability of the finished product. Fundamentals of dimensional metrology involving linear measurement with scaled and vernier instruments are covered in five blocks of work designed for a quinmester course of 135 clock hours. Prerequisite for this course is one year of basic aviation mechanics. Textbooks, laboratory and training manuals, and a film to be used with the outline are listed in the bibliography. Specific behavioral objectives are given for each instruction block, and a posttest with answer key is appended. (Author/AJ)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

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Course Outline
INTRODUCTION TO MEASUREMENT AND
THE USE OF SCALED INSTRUMENTS
(Aviation Quality Control 1 - 9225)

Department 48 - Course 9225.01

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

CE 001 413

D A D E C O U N T Y P U B L I C S C H O O L S
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M I A M I, F L O R I D A 33132

ED 092684

Course Outline

AVIATION QUALITY CONTROL 1 - 9225
(Introduction to Measurement and the Use of Scaled Instruments)

Department 48 - Course 9225.01

the division of

VOCATIONAL, TECHNICAL AND ADULT EDUCATION

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Dade County Public Schools
Miami, Florida 33132

Published by the Dade County School Board

Course Description

9225	48	9225.01	Introduction to Measurement and the Use of Scaled Instruments
State Category Number	County Dept. Number	County Course Number	Course Title

This quinmester course consists of the history and fundamentals of Dimensional Metrology. The techniques of using and reading scaled instruments, the reading of Vernier Scales, and the calibration and care of these instruments are also covered.

Indicator of Success: The student must have had one year of basic Aviation Mechanics.

Clock hours: 135

PREFACE

The following quinmester course outline is entitled "Introduction to Measurement and the Use of Scaled Instruments". This is the first quinmester course of the eleventh year course No. 9225. There will be four more quinmesters as follows:

9225.02 Micrometer Instruments
9225.03 Gage Blocks and Dial Indicators
9225.04 High Amplification Instruments
9225.05 Calibration of Measuring Instruments

This course outline will serve as a guide to the high school student who wishes to pursue the highly exacting field of checking, gaging and measuring parts to insure quality and reliability of the finished product.

Fundamentals of dimensional metrology involving linear measurement with scaled and vernier instruments will be covered in five blocks of work in approximately 135 hours.

Prerequisite for this course is one year of basic Aviation Mechanics. This is to give the student the necessary background in mechanics.

Adequate laboratory time and actual experience on aircraft and other equipment will be provided to develop skills in the student. The student is expected to be proficient in, not just familiar with these techniques.

Motion picture films, color slides and transparancies will be used to help apply the techniques needed in this course.

Study periods, group discussions and extensive use of textbooks, laboratory and training manuals will be used. These are listed along with the other references and periodicals in the bibliography.

This outline was developed through the cooperative efforts of the instructional and supervisory personnel, the Quinmester Advisory Committee, and the Vocational Teacher Education Service, and has been approved by the Dade County Vocational Curriculum Committee.

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with Suggested Hourly Breakdown

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BLOCK

I. INTRODUCTION (10 hours)	
Reasons for Measurement	1
The Language of Measurement	1
II. SYSTEMS OF MEASUREMENT (20 hours)	
Comparison of the New Systems with the Old	1
The Metric Unit System	1
Terminology Used with the Decimal Inch System	1
Rounding Off Numbers	2
III. MEASUREMENT WITH GRADUATED SCALES (30 hours)	
Steel Rule Scales	2
Reference Points on Rulers	2
Observational Error in Reading Scales	2
Manipulative Error in Handling Rules	2
Types of Rules in Common Use	2
Types of Scales on Rules	2
IV. SCALED INSTRUMENTS (40 hours)	
Depth Gage Instrument	3
Combination Square Instrument	3
Caliber Instruments	3
Importance of Gaging Pressure	3
Surface Gages	3
Pocket Slide Caliper	3
V. VERNIER INSTRUMENTS (35 hours)	
History of the Vernier Scale	4
Reading a Vernier Scale Instrument	4
Advantages and Disadvantages of the Vernier Scale	4

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Types of Measuring Instruments Using the Vernier Scale 4

VI. QUINMESTER POST TEST

APPENDIX: QUINMESTER POST TEST SAMPLE 7

GOALS

The aviation quality control student must be able to:

1. Develop skills in the use of close tolerance measurements.
2. Develop the attitudes of patience and persistence to gain maximum accuracy.
3. Develop the habits of cleanliness of person and work area.
4. Be aware of the responsibility involved in his chosen work.
5. Maintain the standards required for the field.
6. Control quality of the finished product.

SPECIFIC BLOCK OBJECTIVES

BLOCK I - INTRODUCTION

The student must be able to:

1. State how accurate measurement is used to control manufacture.
2. Define the terms accuracy and precision.
3. List the nomenclature used in Dimensional Metrology.

BLOCK II - SYSTEMS OF MEASUREMENT

The student must be able to:

1. Compare the new systems of measurement with the old.
2. Differentiate between the fractional and the decimal inch.
3. Explain the metric system of measurement, state method of conversion to decimal inch.
4. Demonstrate how to round up and round down numbers.

BLOCK III - MEASUREMENT WITH GRADUATED SCALES

The student must be able to:

1. Read the steel scale.
2. Explain discrimination.
3. Demonstrate points of reference.
4. Demonstrate two kinds of error encountered in reading scales.

BLOCK IV - SCALED INSTRUMENTS

The student must be able to:

1. Use and read the depth gage.
2. Demonstrate the uses of the combination square.
3. Demonstrate proper gaging pressure.
4. Set up and use surface gages.

BLOCK V - VERNIER INSTRUMENTS

The student must be able to:

1. Read a vernier scale.
2. Demonstrate and compare two methods of measurement.
3. Set up and demonstrate the techniques of using the vernier caliper, vernier depth gage, and vernier height gage.

Course Outline

AVIATION QUALITY CONTROL 1 - 9225
(Introduction to Measurement and
the Use of Scaled Instruments)

Department 48 - Course 9225.01

I. INTRODUCTION

A. Reasons for Measurement
1. Measurement to make things
2. Measurement to control manufacture
3. Measurement for progress

B. The Language of Measurement
1. Terminology used in measurement
a. Accuracy
b. Precision
c. Reliability
d. Repeatability
e. Tolerance
f. Allowance
2. Accuracy versus precision
a. Number of readings in tolerance
b. Dispersion of readings

II. SYSTEMS OF MEASUREMENT

A. Comparison of the New Systems with the Old
1. Fractional inch versus decimal inch
2. Metric unit versus decimal inch

B. The Metric Unit System
1. The meter
2. The millimeter
3. The liter
4. The kilo
5. The gram

C. Terminology Used with the Decimal Inch System
1. The mil
2. The mike

II. SYSTEMS OF MEASUREMENT (Contd.)

D. Rounding Off Numbers
   1. When number is more than five
   2. When number is less than five
   3. When number is five

III. MEASUREMENT WITH GRADUATED SCALES

A. Steel Rule Scales
   1. Scale graduations
      a. Fractional inch
      b. Decimal inch
   2. Discrimination of Scales
      a. Precision scales
      b. Common rules

B. Reference Points on Rulers
   1. Where located on scale
   2. Proper alignment of rule
   3. How this affects precision

C. Observational Error in Reading Scales
   1. Parallex error
   2. Interpolation

D. Manipulative Error in Handling Rules
   1. Improper reference point
   2. Instrument held in improper position

E. Types of Rules in Common Use
   1. Hook rule
   2. Pin rule
   3. Rules of short length with holders
   4. Flexible rules
   5. Techniques of using rules

F. Types of Scales on Rules
   1. Architects scale
   2. Engineers scale
   3. Mechanics scale
   4. Metric scale

IV. SCALED INSTRUMENTS

A. Depth Gage Instrument
   1. Rule of the depth gage
   2. Scale of the depth gage
   3. Base of the depth gage
   4. Techniques of using depth gage

B. Combination Square Instrument
   1. Protractor head of combination square
   2. Center head of combination square
   3. Square head of combination square
   4. Techniques and work precautions in using the combination square

C. Caliber Instruments
   1. Dividers
      a. Types of dividers
      b. Techniques in using dividers
      c. Safety and work precautions to observe in using dividers
   2. Outside calipers
      a. Setting the reference and measurement points
      b. Work precautions to observe to avoid errors
   3. Inside calipers
      a. Setting reference and measured points
      b. Work precautions to observe to avoid errors
   4. Hermaphrodite calipers
      a. Where this type of instrument is used
      b. Techniques in using the hermaphrodite caliper

D. Importance of Gaging Pressure
   1. What is gaging pressure
   2. How it is used
   3. How it is adjusted

E. Surface Gages
   1. The surface gage as a layout tool
   2. Attachments used with a surface gage
   3. Techniques and work precautions to observe in using the surface gage

F. Pocket Slide Caliper
   1. Discrimination of the pocket slide caliper
   2. Its use as a measuring instrument

V. VERNIER INSTRUMENTS

A. History of the Vernier Scale
   1. Invention of the vernier scale
   2. Principle upon which the vernier scale works
   3. How the vernier scale is adapted to measuring instruments

B. Reading a Vernier Scale Instrument
   1. The 10 part vernier scale
   2. The 25 part vernier scale
   3. The 50 part vernier scale
   4. The metric vernier scale

C. Advantages and Disadvantages of the Vernier Scale Instrument
   1. The problem of parallex
   2. How the vernier amplifies the movement

D. Methods of Measurement
   1. Interchange method
   2. Displacement method
   3. Conformation to Abbe's Law

E. Types of Measuring Instruments Using the Vernier Scale
   1. The vernier caliper
      a. Types and styles of vernier caliper
      b. Techniques of manipulating and reading the vernier caliper
      c. Work precautions to observe to avoid errors
   2. The vernier depth gage
      a. Useable limits of the vernier depth gage
      b. Techniques of manipulating and reading the vernier depth gage
      c. Work precautions to be observed to avoid errors
   3. The vernier height gage
      a. Types and styles of vernier height gages
      b. Inherent weakness of the vernier height gage
      c. Attachments used with the vernier height gage
      d. Techniques involved in using the vernier height gage
      e. The importance of the reference surface
      f. Work precautions to be observed to avoid errors

VI. QUINMESTER POST TEST

BIBLIOGRAPHY
(Introduction to Measurement and
the Use of Scaled Instruments)

Basic Reference:

1. Busch, Ted. Fundamentals of Dimensional Metrology, Wilkie Brothers Foundation. Albany, New York: Delmar Publishers, Inc., 1966. The above consists of a text of 428 pages and a lab workbook of 226 pages.

Supplementary References:

2. Juran, J.M. Quality Control Handbook. 2nd ed. New York: McGraw Hill Book Company, Inc., 1951. Pp. 800.

3. Kennedy, Clifford W., and Andrews, Donald E. Inspecting and Gaging. New York: Industrial Press, Inc., 1967. Pp. 590.

Films:

1. Precisely So. #1-13109. 16mm. 15 min. B/W. Sound. Lindsey Hopkins Materials Laboratory.

2. Profile in Precision. 20 min. Color. Sound. 1969. Brown & Sharp Manufacturing Company.

3. Steel Rule. #5-15. 16mm. 18 min. B/W. Sound. G.T. Baker Aviation School.

4. Tools and Rules for Precision Measuring, The. 16mm. 38 min. B/W. 1969. L.S. Starrett Co.

A P P E N D I X

Quinmester Post Test Sample

QUINMESTER POST TEST
(Introduction to Measurement and
the Use of Scaled Instruments)

Name_____ Date_____ Score_____

1. What are the fundamental quantities with which metrology is involved?

2. What is the term used for: 0.001" 0.0001"?

3. What is the principal dimensional measurement?

4. Define a linear measurement.

5. Every measurement begins at the _____ point.

6. In defining an edge, an inside edge is more than _____ deg. of material and an outside edge is less than _____deg. of material.

7. Define the following terms: PRECISION, ACCURACY, RELIABILITY.

8. What is the earliest recorded standard?

9. What is the accepted conversion factor between the metric system and the decimal inch system? _____mm

10. Express the accepted rule for rounding off numbers.

11. The fineness of the scale divisions of an instrument is called _____. It is the smallest division of the scale that can be read reliably.

12. What is the smallest division on the average steel rule?

13. Explain what is meant by the term PARALLAX.

14. When we unconsciously influence each measurement we make we call this _____.

15. For most precise measurements several readings should be taken and _____.

16. A popular modification of the steel rule used to measure holes, grooves, and recesses is called a _____.

17. The simple caliper is used to _____ measurement and this is known as the _____ method.

18. What is the discrimination of a vernier caliper?

19. What is the principal of the vernier scales?

20. Underline which measurement method applies to the vernier caliper: INTERCHANGE METHOD, DISPLACEMENT METHOD.

21. Briefly explain Abbe's Law.

22. In checking the condition of a vernier caliper what are some of the things you would look for?

23. What is meant by the term TOLERANCE as applied to measurement?

24. What is the major problem with the use of vernier height gages in measurement?

25. What means of amplification for measurement have we used thus far in our course?

26. Using the correct terms, name the four parts of a combination set.

27. Name two pieces of equipment used to support parts being measured that we have used to date. Use the correct terminology.

28. Using the correct nomenclature, name at least five parts of a vernier caliper.

29. Why is it important to clean the instrument before using?

ANSWER KEY TO QUINMESTER POST TEST
(Introduction to Measurement and
the Use of Scaled Instruments)

1. Mass, Length, Time.

2. One Mil, One Tenth Mil.

3. Length.

4. Distance between two points.

5. Reference.

6. 180 deg., 180 deg.

7. Precision -- Dispersion of Readings
   Accuracy -- Number of Readings within desired area
   Reliability -- Proximity of measured part with planned outcome.

8. Egyptian Royal Cubit.

9. 24.5

10. Higher than 5, preceding number is raised one.
    Less than 5, preceding number remains.
    Number to be rounded off is 5, preceding number if even stays the same, if odd raise one.

11. Discrimination.

12. 1/64 inch.

13. Apparent or false reading obtained by shifting position of the eye to the scale and the work.

14. Bias.

15. Averaged.

16. Depth gage.

17. Transfer, interchange.

18. One mil.

19. Ability of the eye to align two lines on a scale.

20. Displacement method.

21. Line of measurement must be in line with part being measured.

22. Worn nibs or jaws, jaws out of alignment or not parallel, binding of movable jaw on main beam, severe scratches on beam scale or vernier scale.

23. Limits within which work will be accepted.

24. Instability due to height.

25. Magnifying glass, vernier scale.

26. 1. Blade
    2. Protractor head
    3. Square head
    4. Center head

27. Bench Center, "V" Blocks, Vise.

28. 1. Main beam
    2. Nibs
    3. Fixed Jaw
    4. Movable Jaw
    5. Vernier Scale

29. Scales can be scratched and worn, dirt has dimension and can be measured.